Department of Defense Laboratory Civilian Science and Engineering Workforce - 2011

May 2011

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
MAY 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Department of Defense Laboratory Civilian Science and Engineering Workforce - 2011	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Institute for Defense Analysis (IDA),4850 Mark Center Dr,Alexandria,VA,22311**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**41**	

Introduction

In 2008, the Institute for Defense Analysis (IDA), was commissioned by the then Director of Defense Research and Engineering (now ASD(R&E)), to conduct an assessment of the current Department of Defense (DoD) science and engineering (S&E) workforce as well as projections into the future, in order to be used as inputs for policy and funding decisions. Their report, "Assessment of the DoD Laboratory Science and Engineering Workforce," was approved for public release in June 2009.[1]

In March 2011, Dr. John Fischer, Director of the Defense Laboratory Enterprise (DLE), tasked Diligent Innovations to update the 2008 IDA report, in order to identify if the overall health of the S&E workforce in the DoD laboratories has improved since the IDA report as well as project future trends in the S&E workforce within the DoD laboratories.[2] The charts and figures throughout this report are reflective of those in the IDA report in order to ensure consistency and so the results can easily be compared to those from 2008.

The Laboratories Office and Diligent Innovations would like to thank Ms. Betty Duffield and Mr. Frank Hushek from DoD Civilian Personnel Management Service (CPMS) for providing the personnel data used to update this report as well as Dr. Warren Gardner for his effort in editing this study throughout its duration. Their assistance was critical in being able to promptly and efficiently create this report.

[1] IDA Paper P-4469
[2] Titled, "Department of Defense Laboratory Civilian Science and Engineering Workforce – 2011"

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Executive Summary

As globalization and technology change continue at ever increasing rates, the need for continuing to support a strong technical base also increases for the Department of Defense (DoD). The core DoD technical base is a cadre of highly skilled scientists and engineers (S&Es) that are required to remain at the forefront of technology development and awareness. In order to maintain this intellectual core, the DoD depends on accurate and updated workforce data as input for policy and funding decisions needed to meet National Security requirements. In the absence of accurate, reliable and timely workforce data, the DoD is forced to make decisions based on assumptions instead of facts, and respond at the tactical versus strategic level.

Dr. John Fischer, Director of the Defense Laboratory Enterprise (DLE), tasked Diligent Innovations to analyze the civilian S&E workforce employed by the DoD laboratories (DoD labs). The objective of this study is to provide the DLE with an assessment of the recent trends and current status of the S&E workforce since the previous study was completed in 2009 by the Institute for Defense Analysis (IDA). The principal tasks were to:

- Determine the size and composition of current civilian S&E workforce in DoD science and technology (S&T) laboratories
- Identify recent trends in the S&E workforce

With the assistance of Ms. Betty Duffield and Mr. Frank Hushek from DoD Civilian Personnel Management Service (CPMS), Diligent Innovations updated the 2009 report by using information provided by the Defense Manpower Data Center (DMDC).

S&E Workforce Composition

Population Size

The total 2011 DoD civilian S&E workforce is comprised of 108,703 S&Es. This population represents an increase of 12.3% from the 2008 data. The DoD labs that are the focus of this study (see Table A-1) employ 36,788 (34%) of those S&Es, which is an increase of 4% since 2008. Civilian engineers outnumber scientists throughout DoD (67% vs. 33%) and are more numerous in the DoD labs (74% vs. 26%).

Age

Since 2008, the DoD labs have seen an increase in the total percentage of S&Es 30 years and under, as well as 30-34 year olds. These groups make up approximately one-third of the total DoD lab population of 36,788 or 17% and 14% respectively. However, the largest population of S&Es within the laboratories is between the ages of 45-49 and 50-54, which make up 37% of the total population of the 36,788 DoD lab S&Es.

Education

As is the case in the current U.S. S&E workforce, baccalaureates dominate the current DoD labs civilian S&E workforce, with 63% holding a bachelor's degree. The remaining DoD lab S&E educational level consists of 26% master's level degrees and 9% for individuals with PhDs. These numbers are comparable to the current DoD S&E workforce at 60% bachelor's, 26% master's, and 6% PhDs.

Gender and Race

Women comprised 18% of the 36,788 DoD lab workforce in 2011, and are on average 4 years younger than their male counterparts in the DoD labs when compared at equivalent educational levels. Asian's represent the largest minority population within the DoD labs S&E workforce at 7%, while Blacks and Hispanics make up approximately 4.6% and 4 % respectively.

Trends in the S&E Workforce

Occupational Job Series

Between 2008 and 2011, electronics engineering saw a significant decline in population in all of the Services, as did operations research. However, the DoD lab S&E workforce experienced a recent hiring resurgence in five of the twelve prominent occupational series[3]:

Occupation	2008	2011	Increase/Decrease	% Increase/Decrease
General Engineering	3,490	4,403	**+913**	**+26.2**
Mechanical Engineering	5,292	5,703	**+411**	**+7.8%**
Aerospace Engineering	1,995	2,207	**+212**	**+10.6%**
Electrical Engineering	982	1,193	**+211**	**+21.5%**
Chemistry	744	873	**+129**	**+17.3%**

[3] The remaining prominent occupational series and their associated increases are individuals in computer science (+77/2.6%), physics (+67/4.6%), computer engineering (+58/2.7%), general physical science (+36/5.9%), and mathematics (+12/1.9%). See tables II-1 and II-2.

Occupation	2008	2011	Increase/Decrease	% Increase/Decrease
Operations Research	869	703	**-166**	**-19.1%**
Electronics Engineering	9,919	9,103	**-816**	**-8.2%**

Age and Education

Since 2008, the DoD Lab S&E workforce population became slightly younger with a median age of 43.8 versus 44. This slight demographic shift can partially be attributed to an influx of S&Es aged 34 and under as well as the retirement of individuals aged 60-64. Due to the influx of younger S&Es, the total number of S&ES with only a bachelor's degree increased 3 percent (63%), while the number of master's and Doctoral degrees fell by 1 percent each to 26 and nine percent respectively.

Gender

From 1998 and 2008, the percentage of women in the DoD labs increased by approximately 1.7 percent. In the three years since the IDA study was published, the percentage of women in the DoD labs has increased an additional 1.3 percent from 2008 to 2011. If the growth of women S&Es within the DoD labs remains constant, the percentage of women in the DoD labs in 2020 will be approximately 20 percent.

Gender[4]	%/N=	2020	2011	2008	1998
Male	%	80%	83.2%	84.5%	86.2%
	N=	28,108	30,607	29,805	27,540
Female	%	20%	16.8%	15.5%	13.8%
	N=	7,027	6,180	5,467	4,409

[4] The total DoD lab S&E populations are as follows: 1998 – 31,949; 2008 – 35,272; 2011 – 36,788; 2020 – 35,135 (Estimated)

Section I

Methodology

As in the 2009 study, the principal source of workforce data used in the 2011 update was the personnel database maintained by the Defense Manpower Data Center (DMDC). In the 2011 update, DMDC (through Ms. Betty Duffield and the DoD Civilian Personnel Management Service), provided the Laboratories Office the data that captured the workforce data from the entire DoD civilian S&E workforce population as of March 2011. It should be noted that no personally identifying information was collected in this study. The data captured the following information of each S&E individual within the DoD labs:

- Laboratory currently working at (Ex: AFRL)
- Occupational Job Series[5] (Ex: Chemist, General Engineer)
- Educational Level (Ex: Some college, bachelor's, master's, PhD)
- Age (Broken down into 5 year ranges. Ex: 30-34)[6]
- Race
- Gender

Once all the data was collected, the first step was to use the raw data to capture the information for all the S&Es within the DoD labs before separating them into their respective Services. During this time, the S&E occupational job series that were not part of the focus of this study were filtered out in order to remain consistent with series used in the 2009 report. This process provided us with the following data with the DoD labs:

- Total number of S&Es
- Median age of S&Es
- Age breakdown of S&Es by their defined ranges
- Total number of S&Es in each occupational job series
- Total number of S&Es in each educational level
- S&E gender and racial totals

[5] This was also used in determining if the individual was a scientist or an engineer. The complete list of job series is located on page 17.
[6] The 30 and under range is the only exception to this.

With the above data confirmed, the next step was to separate each individual by the Service in which their laboratory has its affiliation with. The resulting data contained the following information:

- Total number of S&Es by DoD lab
- Total number of S&Es by Service in each occupational job series
- Gender composition of S&Es in the labs by Service

The final step was to gather the same raw workforce data that was gathered for the S&Es within the DoD labs for all of the S&Es within the entire DoD, so that the DoD labs could be compared relative to the entire DoD S&E population. Once this information, which included the DoD labs, was gathered, it was processed in order to provide the same data as bulleted above.

Section II

Results

DoD Civilian S&E Workforce Size and Composition: 2011

The total 2011 DoD civilian S&E workforce is comprised of 108,703 S&Es. This population represents an increase of 12.3% from the 2008 data. The DoD labs that are the focus of this study (see Table A-1) employ 36,788 (34%) of those S&Es, which is an increase of 4% since 2008. Civilian engineers outnumber scientists throughout DoD (67% vs. 33%) and are more numerous in the DoD labs (74% vs. 26%).

As shown in **Figure II-1**, electronics engineering, mechanical engineering, general engineering, and computer science represent the largest occupations in DoD labs (accounting for 61% of all civilian DoD lab S&Es in 2011).

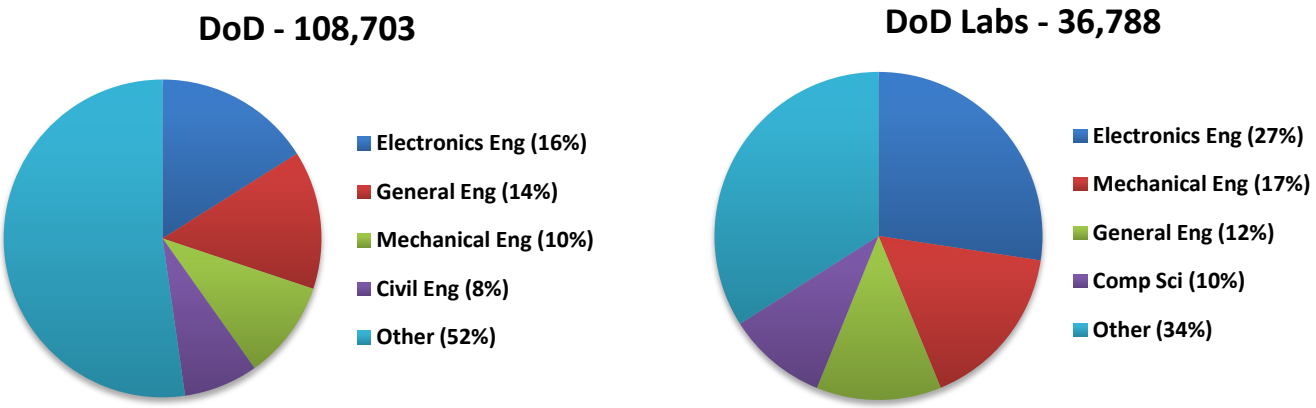
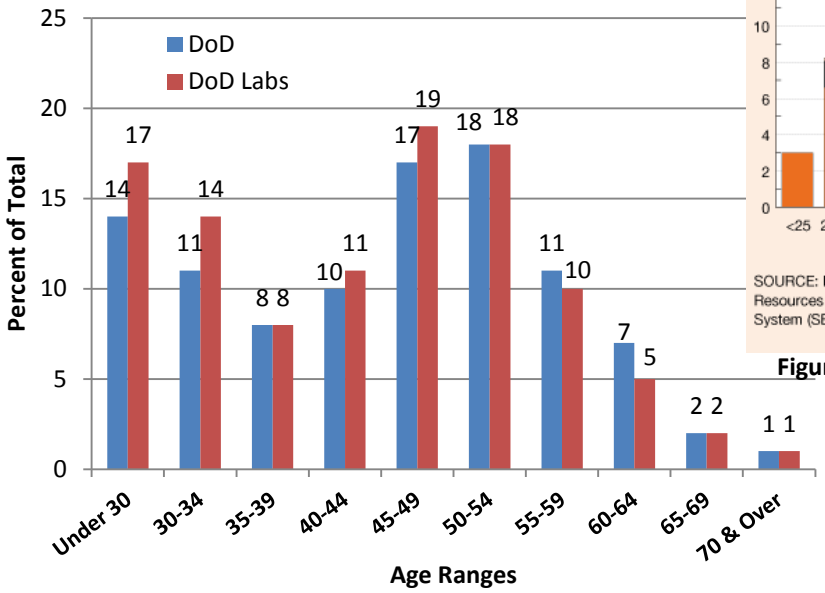


Figure II – 1: Most Populated S&S Occupations in 2011

In 2003, 26% of all S&Es in the U.S. workforce were 50 years old or older. The DoD lab S&E workforce is slightly older, with over one-third of the DoD lab S&E personnel aged 50 years or older (the average age is 43.8). Due to hiring patterns over the past 20 years, the age profile of the DoD lab workforce is bimodal, as shown in **Figure II-2**, with over 19% of the S&E workers between the ages of 45 and 49 and over 17% under 30 years of age. In contrast, the age distribution of all the U.S. S&Es is relatively flat across the age groupings.



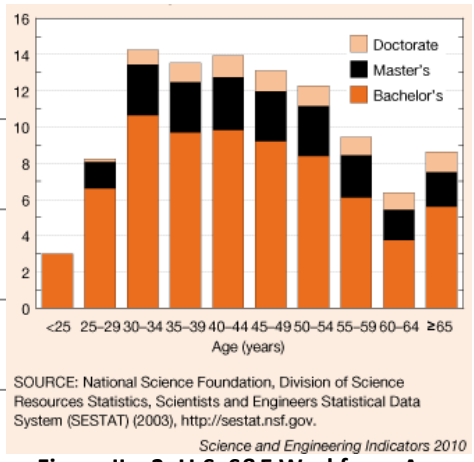


Figure II – 3: U.S. S&E Workforce Age Profile in 2003

Figure II – 2: DoD and DoD Lab S&E Workforce Age Profile in 2011

As is the case in the current U.S. S&E workforce, baccalaureates dominate the current DoD labs civilian S&E workforce, with 63% only holding a bachelor's degree (**Figure II-4**). The remaining DoD lab S&E educational level consists of 26% master's level degrees and 9% for individuals with PhDs. These numbers are comparable to the current DoD S&E workforce are 60% bachelor's, 26% master's, and 6% PhDs.

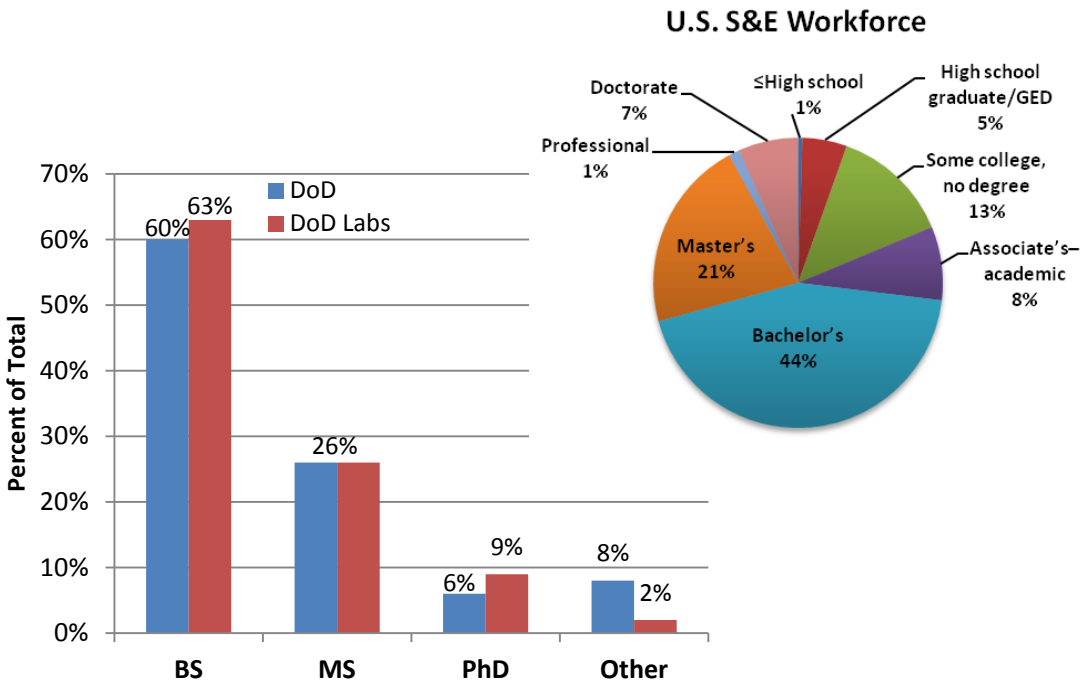


Figure II – 4: DoD and DoD Lab S&E Workforce Education Levels in 2011

For the 2,901 Air Force, 12,630 Army, and 20,905 Navy S&Es, and 241 S&Es located at the USUHS, **Figure II-5** shows the educational degree level composition.

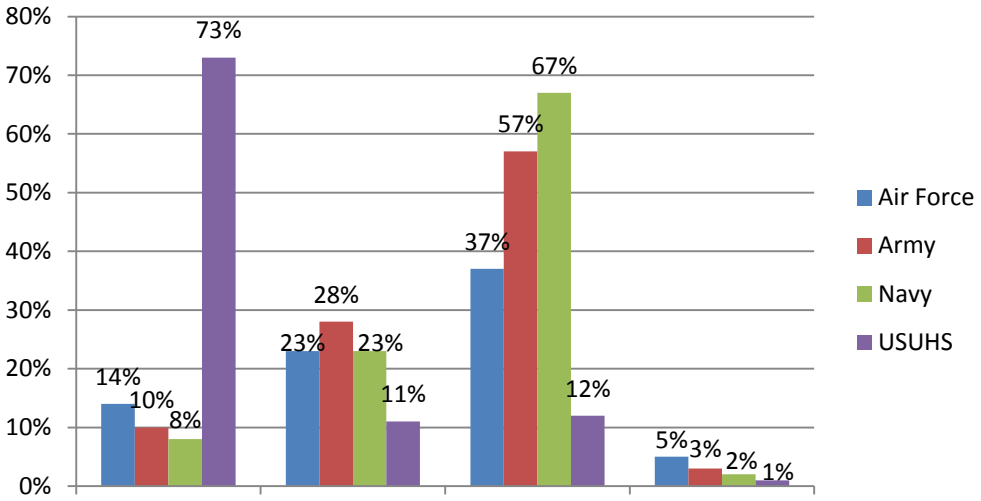


Figure II – 5: DoD Lab S&E Workforce Education Levels in 2011

Women comprised 18% of the 36,788 DoD lab workforce in 2011 (**Figure II-6**), and are on average, are 4 years younger than their male counterparts in the DoD labs when compared at equivalent educational levels. Asians represent the largest minority population within the DoD labs S&E workforce at 7%, while blacks and Hispanics make up approximately 4.6% and 4 % respectively, of the DoD lab S&Es (**Figure II-7**).

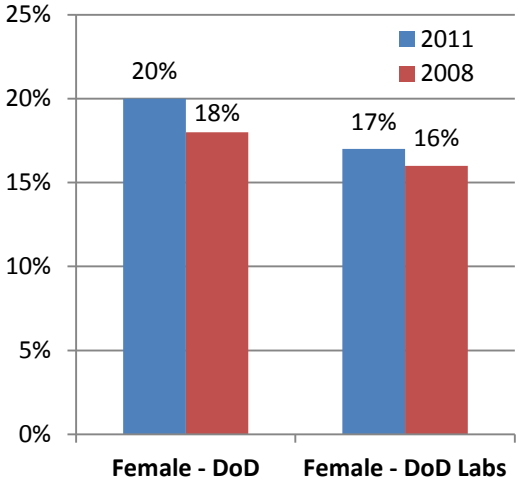


Figure II – 6: Female S&Es in DoD and DoD Labs in 2011

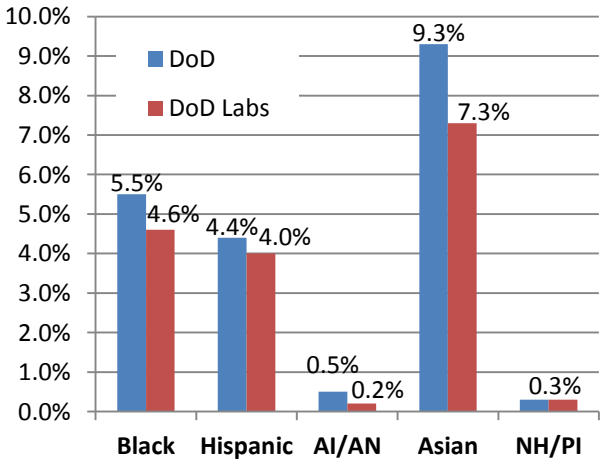


Figure II – 7: Underrepresented Minority S&E Levels in DoD and DoD Labs in 2011

B. Observations on Current and Projected Trends

While it is difficult to specify with confidence the future trends of the DoD Lab workforce, it is possible to gain some perspective by documenting the rise and fall of certain occupations.

Trends in Top DoD S&E Occupations: 1998–2008

Table II-1 and **Table II-2** provide data that compare top S&E occupations in the Air Force, Army and Navy in 2011 and in 2008 (USUHS is omitted). The shaded areas highlight trends in selected occupations. Several patterns are worth noting. Between 2008 and 2011, electronics engineering saw a significant decline in population in all of the Services, as did operations research. However, general, aerospace, and mechanical engineering increased in prominence in all three Services.

Table II-1: Top S&E Occupations in 2011

Air Force			Army			Navy		
Occupation	Count	% Total	Occupation	Count	% Total	Occupation	Count	% Total
Electronics Eng	727	28.8%	General Eng	2799	26.8%	Electronics Eng	6500	34.7%
Aerospace Eng	380	15.0%	Electronics Eng	1876	18.0%	Mechanical Eng	3674	19.6%
General Eng	347	13.7%	Mechanical Eng	1873	17.9%	Computer Sci	2068	11.0%
Materials Eng	241	9.5%	Computer Eng	990	9.5%	General Eng	1257	6.7%
Physics	222	8.8%	Computer Sci	806	7.7%	Aerospace Eng	1201	6.4%
Computer Sci	173	6.8%	Aerospace Eng	626	6.0%	Computer Eng	1105	5.9%
Mechanical Eng	155	6.1%	Gen. Physical Sci	403	3.9%	Physics	996	5.3%
Computer Eng	112	4.4%	Chemistry	386	3.7%	Electrical Eng	853	4.6%
Psychology	86	3.4%	Chemical Eng	357	3.4%	Mathematics	544	2.9%
Gen. Physical Sci	85	3.4%	Civil Eng	319	3.1%	Ops Research	517	2.8%
Total	**2528**	**87.1%**	**Total**	**10435**	**82.6%**	**Total**	**18715**	**89.5%**

Table II-2: Top S&E Occupations in 2008

Air Force			Army			Navy		
Occupation	Count	% Total	Occupation	Count	% Total	Occupation	Count	% Total
Electronics Eng	761	30.1%	General Eng	2202	21.1%	Electronics Eng	7257	38.8%
Aerospace Eng	357	14.1%	Electronics Eng	1840	17.6%	Mechanical Eng	3516	18.8%
General Eng	258	10.2%	Mechanical Eng	1629	15.6%	Computer Sci	2278	12.2%
Materials Eng	240	9.5%	Computer Eng	858	8.2%	Computer Eng	1177	6.3%
Physics	212	8.4%	Aerospace Eng	559	5.4%	Aerospace Eng	1075	5.7%
Computer Sci	144	5.7%	Computer Sci	533	5.1%	General Eng	1026	5.5%
Mechanical Eng	137	5.4%	Gen. Physical Sci	435	4.2%	Physics	959	5.1%
Computer Eng	106	4.2%	Chemistry	340	3.3%	Electrical Eng	690	3.7%
Psychology	70	2.8%	Chemical Eng	333	3.2%	Mathematics	548	2.9%
Chemistry	65	2.6%	Ops Research	305	2.9%	Ops Research	533	2.8%
Total	**2350**	**88.8%**	**Total**	**9034**	**80.9%**	**Total**	**19059**	**88.3%**

C. Anticipated Composition of the Workforce in 2020

While it is difficult to specify with confidence the composition of the DoD lab workforce by the year 2020, recent recruitment trends at least point to the rise and fall of certain occupations that may anticipate near-term hiring needs and choices. In this section, we present three potentially informative indicators: resurgence of key occupations, degree production, and retirement patterns.

1. The Resurgence of Key Occupations in 2011

The DoD lab S&E workforce experienced a recent hiring resurgence in five prominent occupations (electrical engineering, mechanical engineering, aerospace engineering, chemistry, and electrical engineering), as inferred from the new wave of younger workers in select occupations shown in **Figure II-9**.

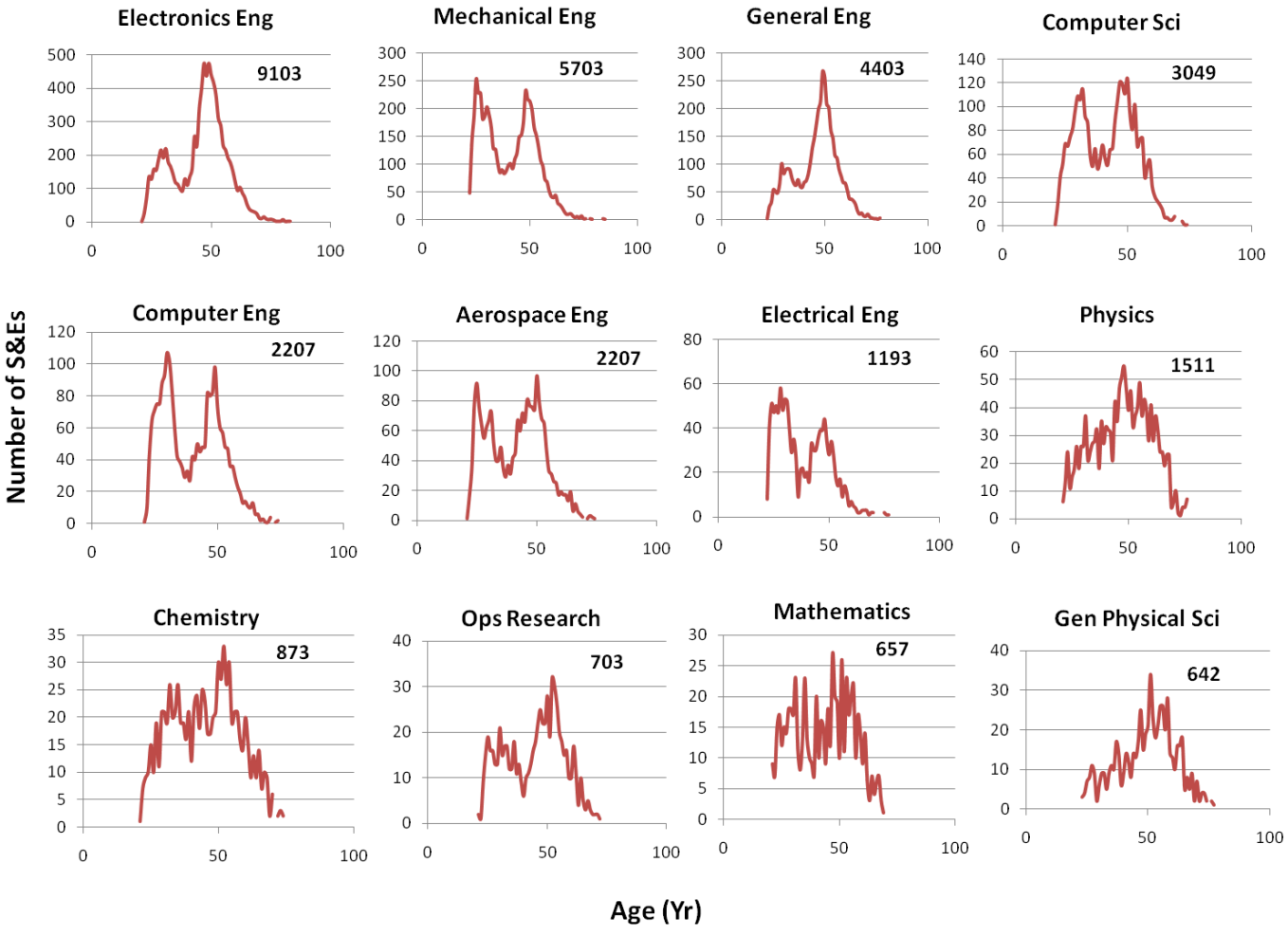


Figure II – 9: Age Profiles of top 12 S&E Occupations1

When the workforce profiles for the top four DoD S&E occupations in 2011 are analyzed by degree level and age of the worker (see **Figure II-10**), it is clear that DoD chiefly hires bachelor's and master's recipients in those top occupations.

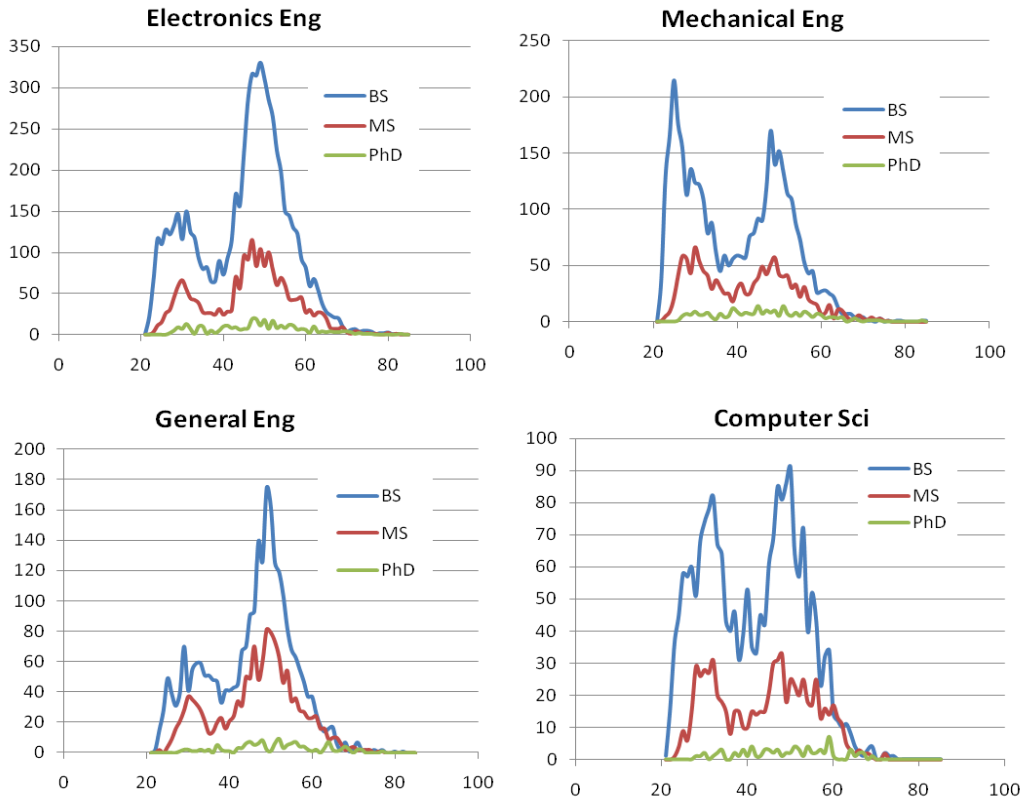


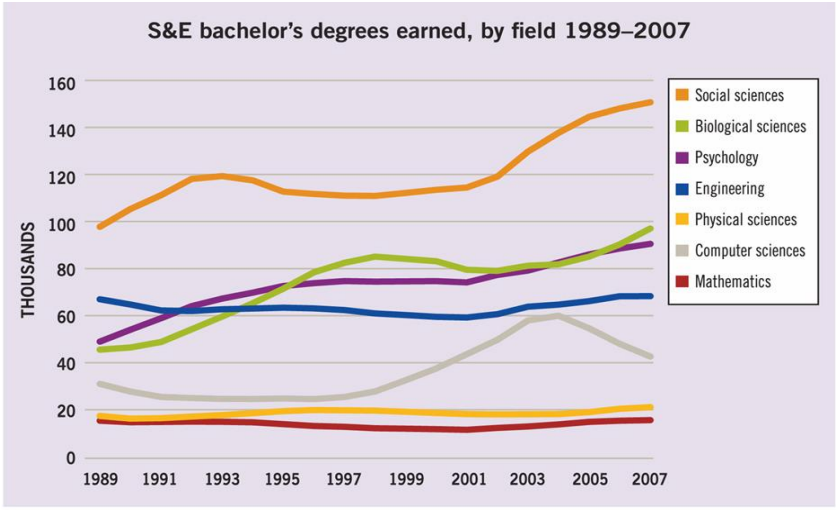
Figure II – 10: Top 4 S&E Occupations in DoD Labs in 2011 by Age and Level of Educations

2. Degree Production in the Top DoD S&E Occupations

U.S. degree trends indicate that the number of degrees awarded to U.S. citizens through 2006 was on the rise in most subfields and at most degree levels in engineering. However, as shown in **Figure II-11**, the number of U.S. computer science baccalaureates continued to decline after reaching peak in 2003, and the number of mathematics and physical sciences baccalaureates remained constant but low. More detail on U.S. science and engineering degree awards, contrasting also U.S. citizens and temporary citizens, is given in Appendix D.

For further exploration, additional insight on S&E personnel requirements can be gleaned from existing DoD planning documents. Examination of position vacancies (unfilled billets) in organizational

unit manning documents (UMDs) may highlight trends in specific hiring needs. More detailed discussions with DoD lab directors about future hiring projections could indicate whether there is a continuing interest in the top fields where shortages may exist and/or whether the emergence of some other occupations is on the rise.



NOTE: Data for 1999 extrapolated.
SEI 2010: **Undergraduate Degree Awards,** Chapter 2.

Figure II – 11: S&E BS Degrees Earned by Field

3. Workforce Composition in 2020

There is no evidence to indicate an imminent large-scale loss of DoD civilian S&Es due to retirement. However, the notable wave of DoD lab S&Es now in their early 50s will approach retirement eligibility in approximately 5 years. Therefore, DoD will need to examine its recruitment and retention efforts to maintain the size and quality of its laboratory workforce in anticipation of workforce changes over the next decade.

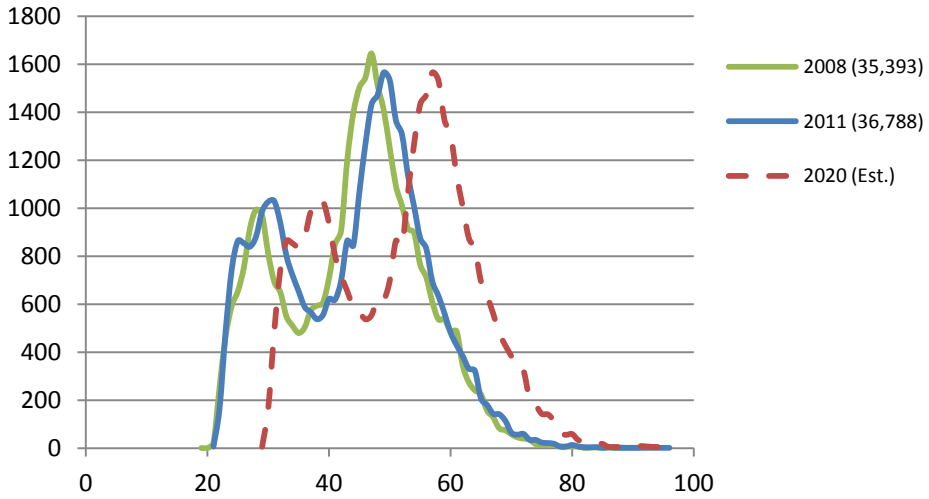


Figure II – 12: Estimated 2020 Age Profile

The solid lines in **Figure II-12** indicate age profile trends of the DoD labs' civilian S&E workforce since 2008. Assuming as a baseline 100% retention and no new hires, the current age profile can be aged 10 years and results in the 2020 age profile projection, indicated by the dashed line in Figure II-12. Through pattern matching that is consistent with past retirement trends, **Figure II-13** show a more credible notional 2020 age profile. The notional 2020 age profile reflects a 5% decrease in workforce size.

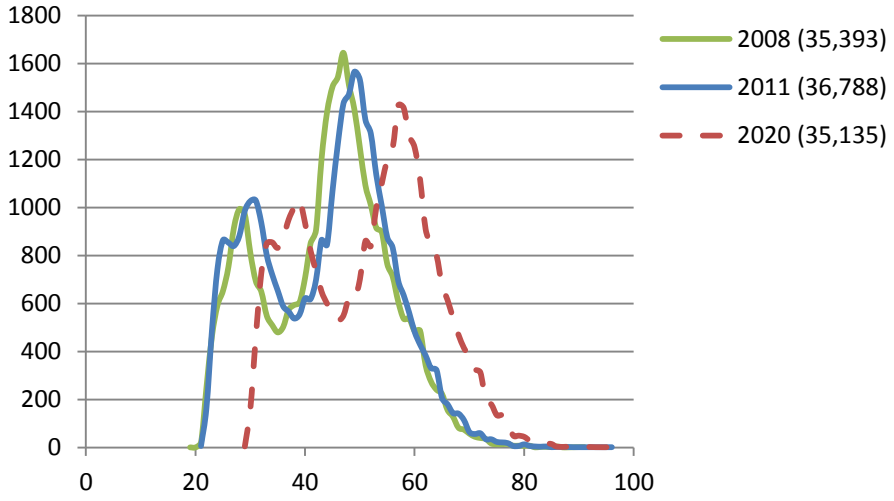


Figure II – 13: Estimated 2020 Age Profile

Appendix A

Defining the Population of Interest

The population of interest for this report is the civilian scientists and engineers (S&E) within the Defense Laboratory Enterprise (DLE). As represented in the diagrams below, the population of interest was defined by selecting those employees who were in the DoD labs (defined by the Unit Identification Code (UIC)) and in an S&E occupation (defined the occupational code). As of March 2011, approximately 108,703 S&E's were in DoD, of whom only one-third (33.7%) are in the DoD labs. From another perspective, approximately 65,771 civilian employees are in the DoD labs, of whom more than half (55.8%) are S&Es.

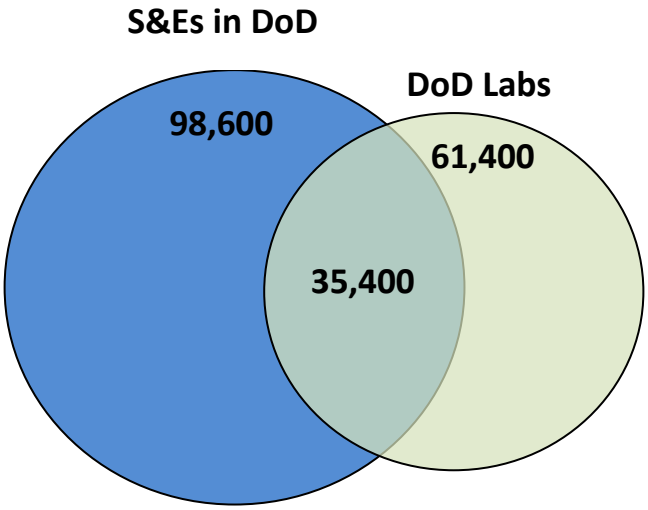


Figure A -1: Population of S&Es in DoD Labs (2008)

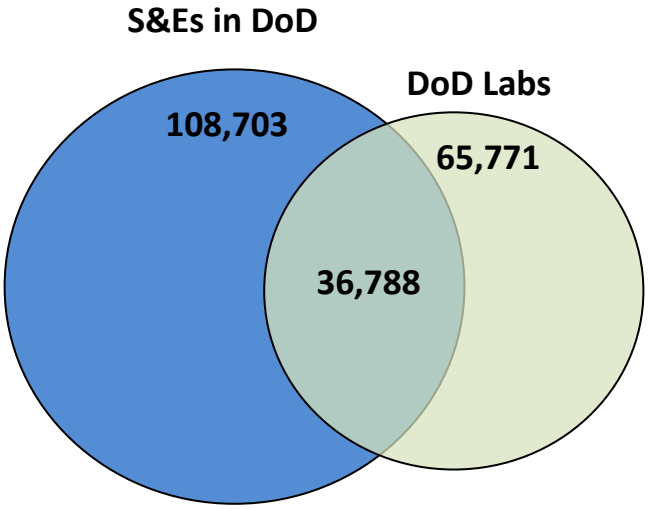


Figure A -2: Population of S&Es in DoD Labs (2011)

A. Department of Defense Laboratories

The list of DoD labs (Table A-1) was compiled based on direction by the Director of the DLE.

DoD Lab	Number of S&Es
United States Air Force	
Air Force Research Lab (AFRL)	2,901
United States Army	
Army Research Lab (ARL)	1,417
Aviation and Missile Research, Development and Engineering Center (AMRDEC)	2,575
Armament Research, Development and Engineering Center (ARDEC)	2,629
Communications-Electronics Research, Development and Engineering Center (CERDEC)	1,962
Tank-Automotive Research, Development and Engineering Center (TARDEC)	1,141
Army Research Institute for the Behavioral and Social Sciences (ARI)	76
Engineering Research and Development Center (ERDC)	1,108
Natick Soldier Research, Development and Engineering Center (NSRDEC)	401
Edgewood Chemical Biological Center (ECBC)	717
U.S. Army Medical Research and Material Command (USAMRMC)	482
U.S. Army Space and Missile Defense Technology Center (SMDTC)	233
United States Navy	
Naval Research Laboratory (NRL)	1,786
Naval Air Warfare Center (NAWC)	6,265
Naval Surface Warfare Center (NSWC)	8,951
Naval Undersea Warfare Center (NUWC)	2,554
Space and Naval Warfare Centers (SSCs)	1,253
Naval Medical Research Center (NMRC)	96
Uniformed Services University of Health Sciences	
Armed Forces Radiobiology Research Institute (AFRRI)	241

Other organizations can be added easily into the population of interest, and the analyses can be iterated. Regardless, the current data sample is considered large enough to be representative of the DoD labs.

B. Modifications to list of DoD Labs

Since the 2008 IDA report, there have been several changes to the list of DoD labs that should be noticed:

1. U.S. Army Simulation and Training Technology Center (STTC) and U.S. Army Material Systems Analysis Activity (AMSSA) no longer fall under the purview of the DLE and were not included in this study.
2. Communications-Electronics Research, Development and Engineering Center (CERDEC) also includes the Army Communications Electronics Command (CECOM) Software Engineering Center which was moved from CERDEC during a reorganization, but their workforce still considered part of CERDEC.
3. Natick Soldier Research, Development and Engineering Center (NSRDEC) and Edgewood Chemical Biological Center (ECBD) now report their workforce data separately instead of jointly.
4. Due to BRAC and realignment, Naval Heath Research Center (NHRC) and its previous subordinate commands, are now a subordinate command to the Naval Medical Research Center (NMRC), but their workforce data is still reported within NMRC.
5. The Uniformed Services University of Health Sciences' Armed Forces Radiobiology Research Institute (AFRRI) has since been added to the list of labs that fall under the purview of the DLE.

C. S&E Occupations

As listed in **Table A-2**, S&Es are defined by 84 occupational categories, according to a commonly accepted Office and Personnel Management (OPM) taxonomy, which has a direct correspondence to the occupation codes used by the DoD. For the purpose of this study, we narrowed down the list of occupations to 69, which are highlighted in blue in Table A-2.

Table A-2: S&E Occupational Categories

Code	Occupation	Code	Occupation	Code	Occupation
101	**Social Science**	602	Medical Officer	**896**	**Industrial Engineering**
110	**Economist**	630	Dietitian and Nutritionist	905	General Attorney
130	**Foreign Affairs**	633	Physical Therapist	1222	Patent Attorney
131	**International Relations**	644	Medical Technologist	**1301**	**General Physical Science**
132	**Intelligence**	662	Optometrist	**1306**	**Health Physics**
150	**Geography**	665	Speech Pathology and Audiology	**1310**	**Physics**
170	**History**	680	Dental Officer	**1313**	**Geophysics**
180	**Psychology**	690	Industrial Hygiene	**1315**	**Hydrology**
184	**Sociology**	701	Veterinary Medical Science	**1320**	**Chemistry**
190	**General Anthropology**	**801**	**General Engineering**	**1321**	**Metallurgy**
193	**Archeology**	**803**	**Safety Engineering**	**1330**	**Astronomy and Space Science**
401	**General Natural Resources Management and Biological Sciences**	**804**	**Fire Protection Engineering**	**1340**	**Meteorology**
403	**Microbiology**	**806**	**Materials Engineering**	**1350**	**Geology**
405	**Pharmacology**	**807**	**Landscape Architect**	**1360**	**Oceanography**
408	**Ecology**	**808**	**Architecture**	**1370**	**Cartography**
410	**Zoology**	**810**	**Civil Engineering**	**1372**	**Geodesy**
413	**Physiology**	**819**	**Environmental Engineering**	**1382**	**Food Technology**
414	**Entomology**	**830**	**Mechanical Engineering**	**1384**	**Textile Technology**
415	**Toxicology**	**840**	**Nuclear Engineering**	**1386**	**Photographic Technology**
434	**Plant Pathology**	**850**	**Electrical Engineering**	**1420**	**Archivist**
435	**Physiology**	**854**	**Computer Engineering**	1501	General Mathematics
457	**Soil Conservation**	**855**	**Electronics Engineering**	**1515**	**Operations Research**
460	**Forestry**	**858**	**Bioengineering and Biomedical Engineering**	**1520**	**Mathematics**
470	**Soil Science**	**861**	**Aerospace Engineering**	**1529**	**Mathematical Statistician**
471	**Agronomy**	**871**	**Naval Architecture**	**1530**	**Statistician**
482	**Fish Biology**	**880**	**Mining Engineer**	**1550**	**Computer Science**
486	**Wildlife Biology**	**890**	**Agricultural Engineering**	1740	Education Services
601	**General Health Science**	**893**	**Chemical Engineering**	1750	Instructional Systems

D. DoD-Wide Scientists and Engineers

To provide context for the DoD lab S&Es, we should examine the breadth of S&Es across the entire DoD. **Figure A-3** shows the Service composition of the 36,788 DoD labs civilian S&E populations of interest. **Figure A-4** shows the Service composition of the 108,703 DoD S&Es.

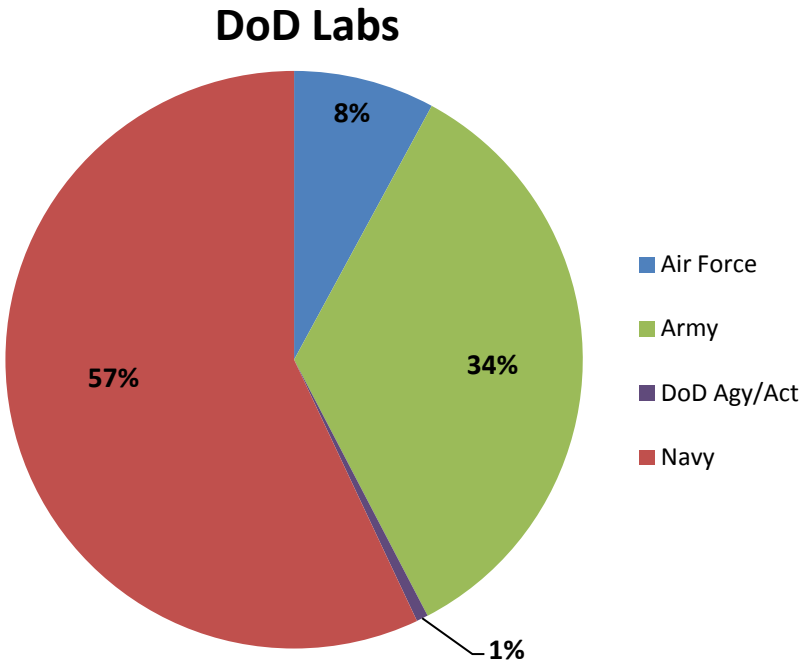


Figure A-3

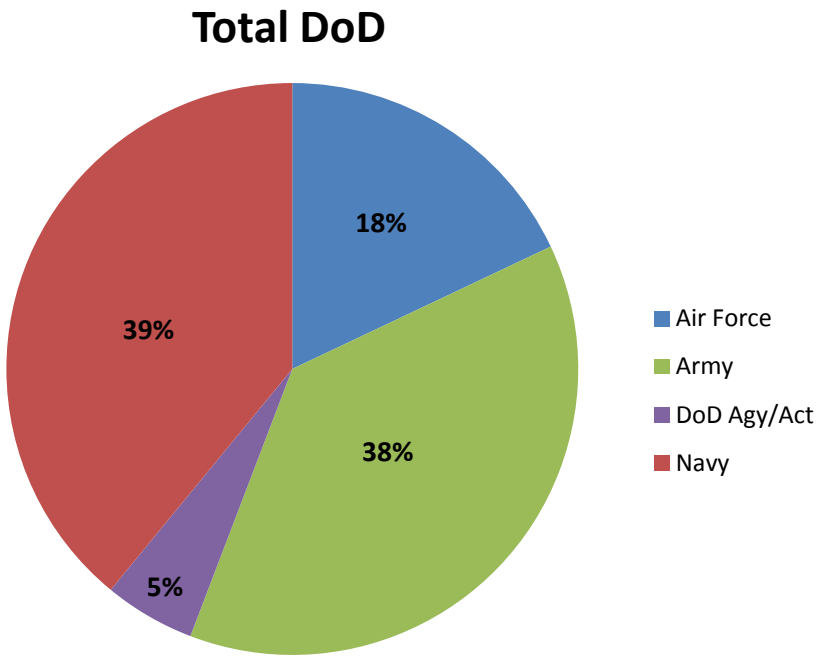


Figure A-4

Appendix B

Race and Gender Composition of
Scientists and Engineers (S&Es) in DoD Labs and Across DoD

This appendix provides data that may be useful in future consideration of race and gender. It should also be noted that no conclusions were made from this data.

These two sections correspond specifically to Department of Defense (DoD) laboratories (DoD labs) and to all of DoD, respectively. For historical perspective, the 2011 results are compared to 1998 and 2008 results to assess demographic trends.

A. Civilian Science and Engineering (S&E) Workforce in DoD Labs

Table B-1 compares the gender make-up of the 36,788 S&Es in the DoD labs in 2011 with the 35,272 S&Es in the lab in 2008.

Table B-1 Gender Composition of Civilian S&Es in DoD Labs in 1998, 2008 and 2011

Gender	2011	2008	1998
Male	83.2%	84.5%	86.2%
Female	16.8%	15.5%	13.8%

Table B-2 shows the race composition by gender for 2011 compared to 2008 and indicates slightly more diversity among female workforce than the male workforce.

Table B-2 Race Composition of Civilian S&Es in DoD Labs in 2008-2011 for the Total Population and by Gender

	2011		
Ethnic Group	**Total**	**Male**	**Female**
White	79.3%	80.6%	73.3%
Asian	10.8%	10.5%	12.1%
Black	4.5%	3.7%	8.4%
Hispanic	4.1%	4.0%	4.5%
American Indian/Alaska Native	0.4%	0.4%	0.4%
2008			
White	80.2%	81.5%	73.4%
Asian	11.0%	10.6%	13.1%
Black	4.3%	3.5%	8.7%
Hispanic	4.0%	4.0%	4.3%
American Indian/Alaska Native	0.5%	0.5%	0.5%

Table B-3 shows the gender composition of each Service within the DoD labs in 2011 and indicates that the Army has slightly more gender diversity than the DoD overall. The Air Force has the lowest fraction of female S&Es among DoD civilian lab S&Es.

Table B-3 Gender Composition of Civilian S&Es in DoD Labs 2011 - Total Population by Service

Gender	Total	Army	Navy	Air Force	UHSU
Male	83.2%	81.3%	84.2%	86.1%	59.2%
Female	16.8%	18.7%	15.8%	13.9%	40.8%

Table B-4 shows the education levels by gender in 2011. The distribution of educational attainment for men and women S&Es is similar.

Table B-4 Educational Levels of Civilian S&Es in DoD Labs in 2011 - Total Population by Gender

Educational Level	Total	Male	Female
HS Grad	0.6%	0.6%	0.8%
Some College	1.9%	1.8%	2.1%
Bachelor's Degree	61%	61.1%	60.2%
Master's Degree	24.8%	24.5%	26%
PhD	9.8%	9.8%	9.6%
Professional	0.2%	0.2%	0.1%

Table B-5 shows the top S&E occupations (defined by having a population size of greater than 150) in the DoD Labs by gender in 2011. The shaded areas in Table B-5 indicate notably higher percentages of females in specific occupations (relative to the 16.8% female overall average).

Table B-5 Gender Mix of Top Civilian S&E Occupations in DoD Labs in 2011

Occupation	Population Size	Female	Male
Electronics Engineering	9103	10.4%	89.6%
Mechanical Engineering	5703	10.5%	89.5%
General Engineering	4403	14.6%	85.4%
Computer Science	3049	27.5%	72.5%
Computer Engineering	2207	15.5%	84.5%
Aerospace Engineering	2207	12.1%	87.9%
Physics	1511	10.6%	89.4%
Electrical Engineering	1193	12.7%	87.3%
Chemistry	873	28.9%	71.1%
Operations Research	703	33.7%	66.3%
Mathematics	657	41.1%	58.9%
General Physical Science	642	26.5%	73.5%
Chemical Engineering	624	30.4%	69.6%

Occupation	Population Size	Female	Male
Materials Engineering	599	17.2%	82.8%
General Natural Resources Mgmt and Biological Science	449	44.1%	55.9%
Civil Engineering	358	17.0%	83.0%
Psychology	356	39.6%	60.4%
Industrial Engineering	348	33.0%	67.0%
Naval Architecture	280	12.5%	87.5%
Microbiology	208	44.7%	55.3%

Table B-6 shows the gender mix within individual DoD labs in 2011. The shaded areas indicate notably higher percentages of females in specific organizations (relative to the 16.8% female overall average).

Table B-6 Gender Mix by DoD Lab 2011

DoD Lab	Population Size	Female	Male
Naval Surface Warfare Center (NSWC)	8951	16.1%	83.9%
Naval Air Warfare Center (NAWC)	6265	16.0%	84.0%
Air Force Research Lab (AFRL)	2901	13.9%	86.1%
Armament Research, Development and Engineering Center (ARDEC)	2629	12.6%	87.4%
Aviation and Missile Research, Development and Engineering Center (AMRDEC)	2575	16.4%	83.6%
Naval Undersea Warfare Center (NUWC)	2554	15.5%	84.5%
Communications-Electronics Research, Development and Engineering Center (CERDEC)	1962	16.6%	83.4%
Naval Research Lab (NRL)	1786	13.5%	86.5%
Army Research Lab (ARL)	1417	16.8%	83.2%
Space and Naval Warfare Center (SSCs)	1253	14.1%	85.9%
Tank-Automotive Research, Development and Engineering Center (TARDEC)	1141	18.8%	81.2%
Engineering Research and Development Center (ERDC)	1108	25.6%	74.4%
Edgewood Chemical Biological Center (ECBC)	717	27.1%	72.9%
U.S. Army Medical Research and Material Command (USAMRMC)	482	35.3%	64.7%
Natick Soldier Research, Development and Engineering Center (NSRDEC)	401	35.2%	64.8%

DoD Lab	Population Size	Female	Male
Armed Forces Radiobiology Research Institute (AFRRI)	241	40.7%	59.3%
U.S. Army Space and Missile Defense Technology Center (SMDTC)	233	21.0%	79.0%
Naval Medical Research Center (NMRC)	96	35.4%	64.6%
Army Research Institute for the Behavioral and Social Sciences (ARI)	76	30.3%	69.7%
Grand Total	**36,788**	**16.8%**	**83.1%**

B. Civilian S&E Workforce Across the Entire DoD

For perspective on the DoD lab workforce, the statistics for S&Es throughout DoD were evaluated. The DoD S&E workforce has 108,703 civilian S&Es. This number includes non-degreed S&Es, who account for 12% of the total.

Table B-7 shows the race and gender composition of the DoD civilian S&E workforce in 2011. Note that there were 28 records of ID pending and 46 records of unknown race (54 male; 10 female). Tables B-7 shows that 79.04% are white. The nonwhite composition includes 9.34% Asian and 11.62% of the historically underrepresented minorities. The percentage of women for all races except white is higher. The number of black and Hispanic males is nearly the same, but black females outnumber Hispanic females 2:1.

Table B-7 DoD Civilian S&E Race Mix in 2011 - Total Population and for each Gender

Ethnic Group	Total	Male	Female
White	79.04%	80.56%	73.06%
Asian	9.34%	9.30%	9.55%
Black	5.47%	4.35%	10.07%
Hispanic	4.42%	4.28%	4.98%
Multiracial	0.89%	0.77%	1.36%
American Indian/Alaska Native	0.50%	0.47%	0.60%
Native Hawaiian/Pacific Islander	0.28%	0.26%	0.37%

DoD S&Es are predominantly engineers (66.5%). **Table B-8** shows the gender composition of DoD S&Es: women are 19.6% of DoD S&Es, and, by professional field, 13.9% of engineers are female and

31.1% of scientists are female. In fact, more DoD S&E women are scientists (53.1%) than engineers (46.9%), compared to male engineers (71.3%) and male scientists (28.7%).

Table B-8 Percentage of DoD Civilian S&Es by Gender in 2011 - Total Population and by Field

Gender	Total	Engineer	Scientist
Male	80.4%	86.1%	68.9%
Female	19.6%	13.9%	31.1%

Tables B-9 shows the race composition of DoD S&Es. Approximately 11.3% of DoD engineers are Asian. While DoD S&Es are predominantly engineers (66.5%), Asians, Hispanics, and Native Hawaiian/Pacific Islanders favor engineering even more so: 80.5% of Asians are engineers; 73.8% of Hispanics are engineers; and 71.5% of Native Hawaiian/Pacific Islanders. Conversely, a higher percentage of blacks are in science, compared to all DoD S&Es: 40.8% of blacks are scientists. Blacks comprise 6.7% of DoD scientists.

Table B-9 Number of DoD Civilian S&Es by Race in 2011 - Total Population and by Field

Race	Total	Engineer	Scientist
White	85914	55845	30069
Asian	10156	8177	1979
Black	5945	3517	2428
Hispanic	4801	3543	1258
American Indian/Alaska Native	540	342	198
Native Hawaiian/Pacific Islander	309	221	88
Multiracial	966	590	376
Total	108631[7]	72235	36396

Table B-10 addresses educational levels for each gender. The highest degree held by most S&Es is bachelor's (60.2%), followed by master's (25.6%) and PhDs (5.8%). Women account for 18.8% of S&E bachelor's Degrees, 22% of master's Degrees, and 21.1% of DoD S&Es PhDs.

[7] The total does not reflect 108,703 as some individuals chose not to disclose their race.

Table B-10 DoD S&E Education Levels for each Gender 2011

Educational Level	Total	Male	Female
HS Grad	5.0%	4.0%	1.0%
Some College	3.2%	2.4%	0.8%
Bachelor's Degree	60.2%	49.1%	11.0%
Master's Degree	25.6%	19.9%	5.6%
PhD	5.8%	4.6%	1.2%

Table B-11 shows the racial mix per educational level. Items highlighted in red indicate an increase from 2008. Note: Multiracial was not a category in 2008, so there is no baseline to provide information on an increase in population.

Table B-11 DoD S&E Education Levels by Race and Gender

	HS Grad			Some College			Bachelor's			Master's			Ph.D.			
Race	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	Total
White	83.5	76.2	82	81	75	79.8	79.7	71.6	78.2	81.3	74	79.6	82	79	81.3	79
Asian	4.7	4.6	4.6	4.2	3.9	4.1	9.8	10.6	9.9	9	8.7	8.9	12.8	12.3	12.7	9.4
Black	6.2	10.7	7.1	6.4	12.5	7.9	4.3	9.9	5.3	4.4	11.4	5.9	2	4.2	2.5	5.5
Hispanic	3.9	6.2	4.4	5.8	7.2	6.2	4.7	5.6	4.8	3.9	4	3.9	2	2.3	2.1	4.4
AI/AN	0.5	0.5	0.5	0.8	0.1	0.7	0.5	0.6	0.5	0.4	0.6	0.4	0.5	0.5	0.5	0.5
Multiracial	1	1.6	1.1	1.2	1.3	1.2	0.7	1.3	0.8	0.8	1.4	0.9	0.7	1.5	0.8	0.9
NH/PI	0.2	0.3	0.2	0.2	0.1	0.2	0.3	0.4	0.3	0.2	0.4	0.3	0.1	0.1	0.1	0.3

All numbers are percentages

Appendix C

U.S. and Global S&E Workforce[8]

A. U.S. S&E Workforce

For comparison with the DoD labs and DoD as a whole, the National Science Foundation (NSF) provides trend data on age, retirement patterns, level of education, race and gender of the U.S. S&E workforce as a whole. (All of the analysis and work of this section should be attributed to the National Science Foundation).

Age Distribution of the S&E Workforce

Across all degree levels and fields, 26.4% of the labor force with S&E degrees is older than age 50 (**Figure C-1**). The greatest population density of individuals with S&E degrees occurs between the ages of 40 and 49. **Figure C-2** shows the age distribution of the labor force with S&E degrees broken out by level of degree. In general, the majority of individuals in the labor force with S&E degrees are in their late thirties through their early fifties, with the largest group at ages 40–44.

Figure C-1: Employed S&E degree holders older than 50, by selected field of highest degree: 2006

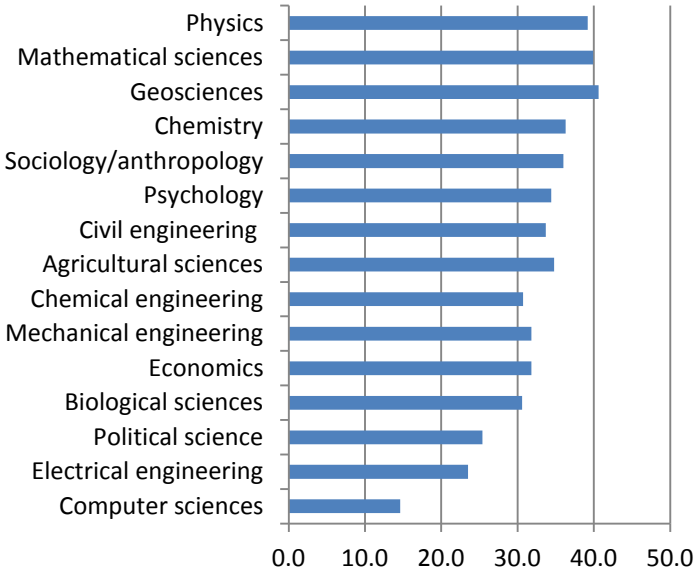
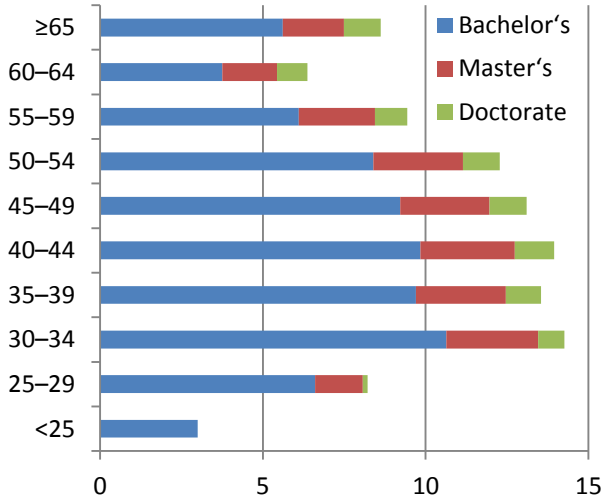


Figure C-2: Age distribution of individuals in labor force with highest degree in S&E: 2003



[8] This appendix is taken directly from the National Science Foundation's *Science and Engineering Indicators: 2010*. Some of the charts have been formatted to make for easier readability.

S&E Workforce Retirement Patterns

Table C-1 summarizes three ways of looking at changes in workforce involvement for S&E degree holders: leaving full-time employment, leaving the workforce, and retiring from a particular job. **Figure C-3** shows data on S&E degree holders working full time at ages 55–69. For all degree levels, the proportion of S&E degree holders who work full time declines fairly steadily by age, but after age 55, full-time employment for doctorate holders becomes significantly greater than for bachelor's and master's degree holders. At age 69, 27% of doctorate holder's work full time, compared with 16% of bachelor's degree recipients. However, of retired S&E degree holders age 71 to 75; only 12% of bachelor's degree holders keep working either full or part time, 17% of master's degree holders, or 19% of doctorate holders.

Labor force participation for individuals with highest degree in S&E, by education level and age: 2003

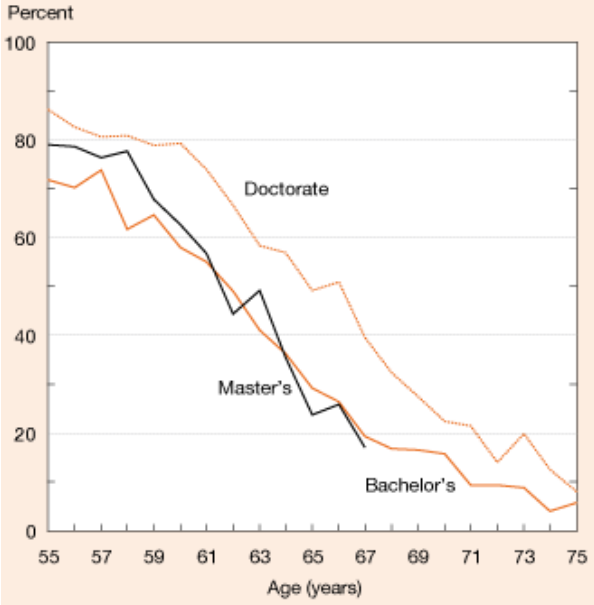
	Age at which more than half were—		
Highest degree	No longer employed full-time	Not in labor force	Ever retired
Bachelor's	61	65	65
Master's	62	66	66
Doctorate	66	69	67

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2003), http://sestat.nsf.gov.

Science and Engineering Indicators 2010

Table C-1

Full-time labor force participation by older individuals with highest degree in S&E, by age and degree level: 2006



NOTES: Calculated from 2-month pooled samples. Data for master's degree holders shown only through age 67 due to small sample sizes.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

Science and Engineering Indicators 2010

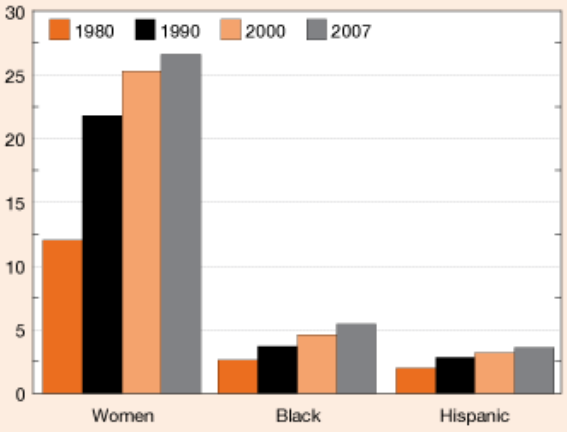
Figure C-3

Women and Minorities in S&E

An important part of the growth of the S&E labor force comes from the increased presence of women and ethnic minorities. Both women and underrepresented ethnic minorities have shown steady growth in their proportion of the S&E labor force.

Census data on S&E occupations from 1980 to 2007 show the number of women in S&E occupations rising from 12% to 27% over those 27 years (**Figure C-4**). **Figure C-5** shows the growth in the number of women with education in S&E for different graduation cohorts and broad fields of degree. The notable exception is in computer and mathematical sciences at the bachelor's degree level, where the proportion of women in the workforce is lower for 2002–05 graduates (27%) than it is for 1972–76 graduates (35%).

College-educated women and racial/ethnic minorities in S&E occupations: 1980, 1990, 2000, and 2007



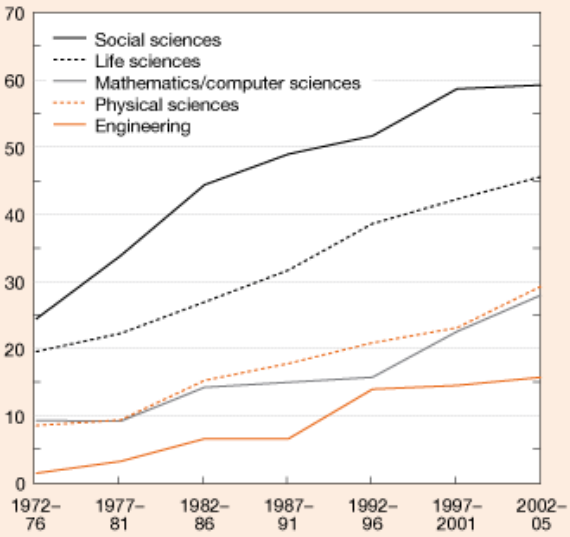
NOTE: Postsecondary S&E teachers not included because they cannot be identified in data source.

SOURCE: University of Michigan, Integrated Public Use Microdata Series, 1980–2000 Decennial Census files and 2007 American Community Survey, http://usa.ipums.org/usa/, special tabulations.

Science and Engineering Indicators 2010

Figure C-4

Representation of women among workers whose highest degree is S&E doctorate, by year of doctorate: 2006



SOURCE: National Science Foundation, Division of Science Resources Statistics, Scientists and Engineers Statistical Data System (SESTAT) (2006), http://sestat.nsf.gov.

Science and Engineering Indicators 2010

Figure C-5

Representation of Racial and Ethnic Minorities in S&E

With the exception of Asians/Pacific Islanders, racial and ethnic minorities represent only a small proportion of those employed in S&E occupations in the United States. Collectively, blacks, Hispanics, and other ethnic groups (the latter category includes American Indians/Alaska Natives) constitute 24% of the total U.S. population, 13% of college graduates, and 10% of college-educated individuals employed in S&E occupations. Conversely, Asians/Pacific Islanders, despite constituting only 5% of the U.S. population, accounted for 7% of college graduates and 14% of those employed in S&E occupations in 2003.

Age Distribution of Racial and Ethnic Minorities

Underrepresented racial and ethnic minorities in the S&E workforce are much younger than non-Hispanic whites in the same S&E jobs (**Figure C-6**), and this difference is even more pronounced for doctorate holders in S&E occupations (**Figure C-7**). This finding could point to an upcoming shift in the overall composition of the S&E workforce. In the near future, a much greater proportion of non-Hispanic white doctorate holders in S&E occupations will be reaching traditional retirement ages, potentially signaling a more rapid increase in the number of non-Hispanic white doctorate holders who will retire or otherwise leave S&E employment.

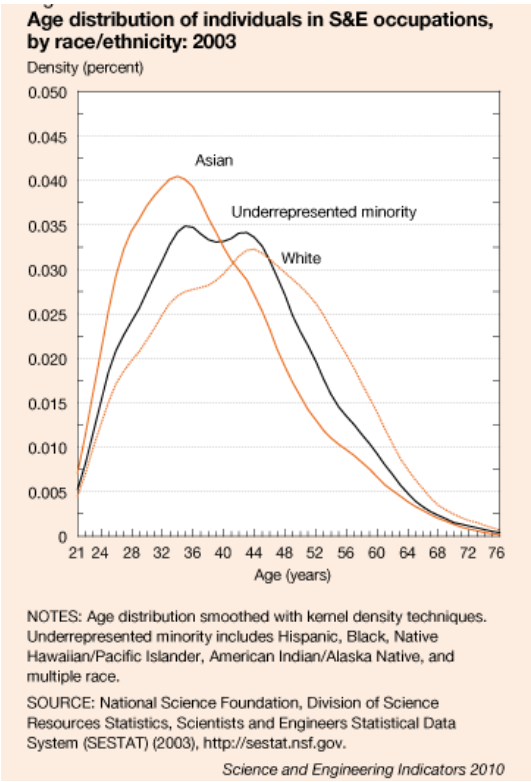


Figure C-6

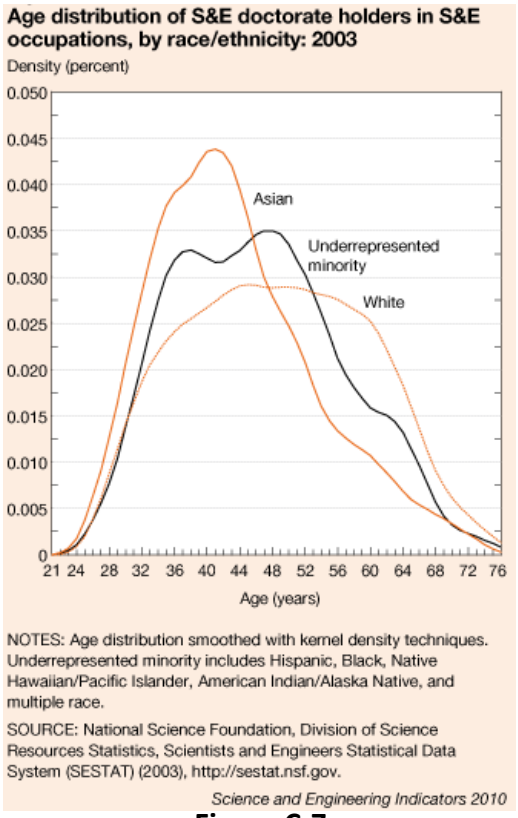


Figure C-7

C. Global S&E Labor Force

Counts of Global S&E Labor Force

There are no comprehensive measures of the global S&E labor force, but fragmentary data on the global S&E labor force suggest that the U.S. world share is continuing to decline, even as U.S. reliance on foreign-born scientists and engineers may be near or at a historic high. Data exist within some national data systems, and some countries report data in standardized form to international agencies such as the Organization for Economic Co-operation and Development (OECD).

OECD collects data on researchers from its member countries and selected other countries. Unfortunately, this source misses many countries that appear to have high levels of S&T activity, including India, Brazil, and Israel. **Figure C-8** shows the growth between 1995 and 2007 in the reported number of researchers in selected countries/economies.

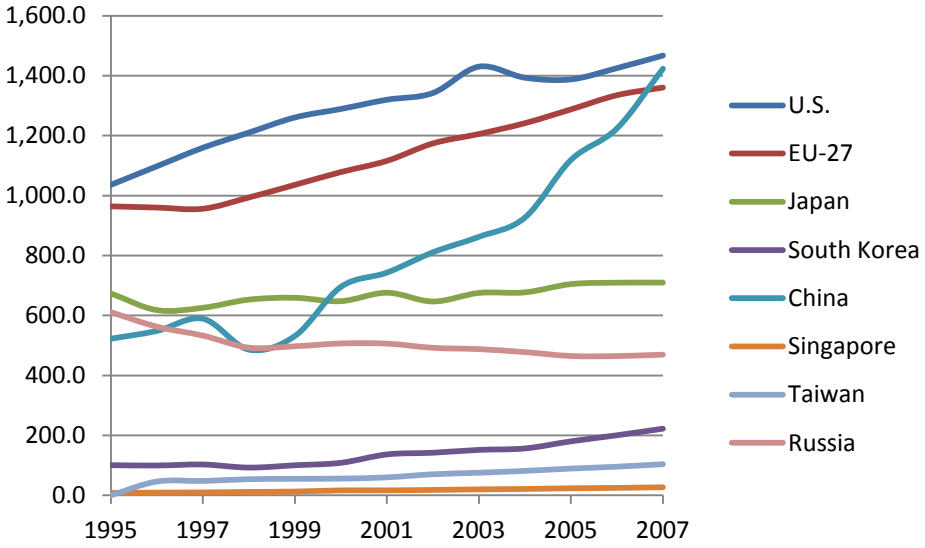


Figure C-8

The United States had about the same growth of researchers as the EU-27, about 40% each over the time period. The number of researchers in Japan rose by just over 5%. Over the same 12-year period, the reported number of researchers in China rose by 173% to more than 1.4 million in 2007—close to the estimated U.S. figure and the number of the combined EU-27. An important caution in interpreting these data is that although countries used a common definition of "researcher" when reporting their data to OECD, there are many judgments necessary to translate from a wide variety of national data systems to the OECD definition.

Highly Skilled Migrants in OECD Countries

Based on their data, **Figure C-9** shows the leading countries of origin of non-natives with tertiary-level education who lived in OECD countries in 2000.

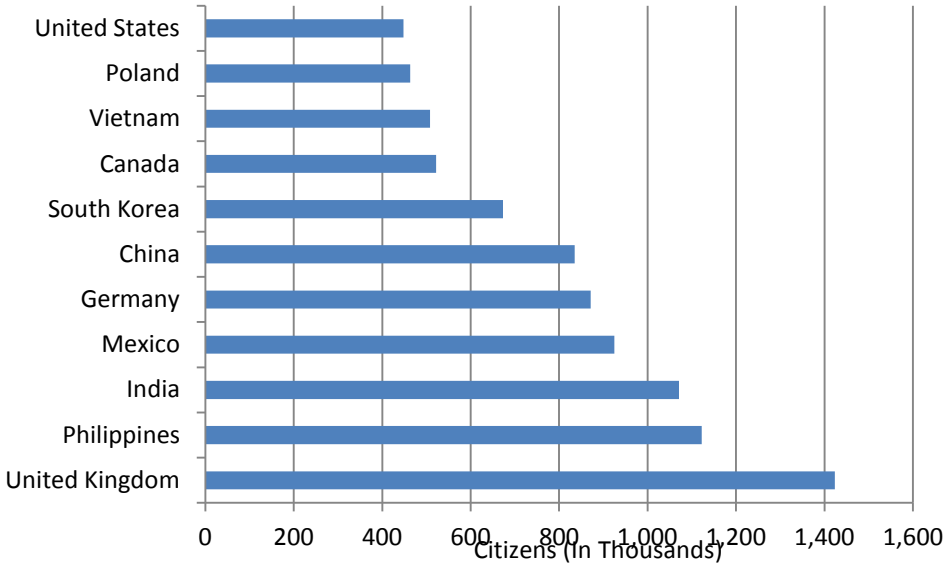


Figure C-9

With 1.4 million, the United Kingdom has the largest high-skilled diaspora. (Although originally used to describe much less voluntary dispersals of population in history, the term diaspora is increasingly used to describe the internationally mobile portion of a country's nationals, which forms a network for contact and information flow. These networks can provide advantages for a country that help mitigate the loss of human capital through migration.) The United States, ranking 11th with 448,000 tertiary educated citizens who live in other OECD countries, has a fairly small high-skilled diaspora compared with its population, and particularly compared with its number of educated workers.

Migration to the United States

The knowledge and specialized skills of scientists and engineers can be transferred across national borders through the physical movement of people. Governments in many industrialized countries increasingly view the immigration of skilled S&E workers as an important contributor to the quality and flexibility of their S&E labor force. Many countries have not only increased their research investments, but have also made encouraging high-skilled immigration an important part of their national economic strategies. The United States has benefited, and continues to benefit, from this international flow of knowledge and personnel (see Regets 2001 for a general discussion of high-skilled migration).

Broadly consistent estimates of U.S. reliance on foreign born scientists and engineers are available from several sources. **Table C-2** shows upward trends in the percentage of foreign-born individuals in U.S. S&E occupations over time.

Table C-2: Estimates of foreign-born individuals in S&E occupations from NSF/SRS and Census Bureau, by educational attainment: 1999, 2000, and 2003

			2003	
Education	1999 NSF/SRS SESTAT	2000 Census 5% PUMS	NSF/SRS SESTAT	Census Bureau ACS
All college educated	15.0	22.4	22.5	25.0
Bachelor's	11.3	16.5	16.3	18.8
Master's	19.4	29.0	29.0	32.0
Doctorate	28.7	37.6	35.6	39.5

The percentage changes since 2000 may appear small but are quite substantial, given the short time span and the overall growth of the number of persons in S&E occupations from 2000 to 2007: of an estimated 341,000 total increase, 100,000 were foreign born.

SESTAT surveys include only individuals who were counted in the most recent Decennial Censuses or who received a U.S. S&E degree, thereby missing recently arrived foreign-born and foreign-educated scientists and engineers. Yet, a large proportion of the foreign-born and foreign-educated members of the S&E labor force are recent arrivals. For example, in 2000, about 43% of all college-educated foreign-born workers in U.S. S&E occupations reported arriving in the United States after 1990; among doctorate holders 62% reported arriving after this date.

The 2000 census data provide a good estimate of the foreign born who were actually in the United States in April 2000 but give no information about those performing S&E tasks in a wide variety of non-S&E occupations (as discussed earlier in this chapter), nor about which postsecondary teachers are in S&E fields. Within these limitations, the Census Bureau's 2007 American Community Survey permits an analysis of trends in the proportion of the foreign born in S&E occupations at each degree level during the current decade. It shows growth of 3 percentage points overall, with an extra 4 percentage points each at the master's degree and doctorate levels. Between 2003 and 2007, employment of college graduates in nonacademic S&E occupations, as measured by the ACS, increased by 345,000: 235,000 U.S. natives and 110,000 foreign-born (**Figure C-10**).

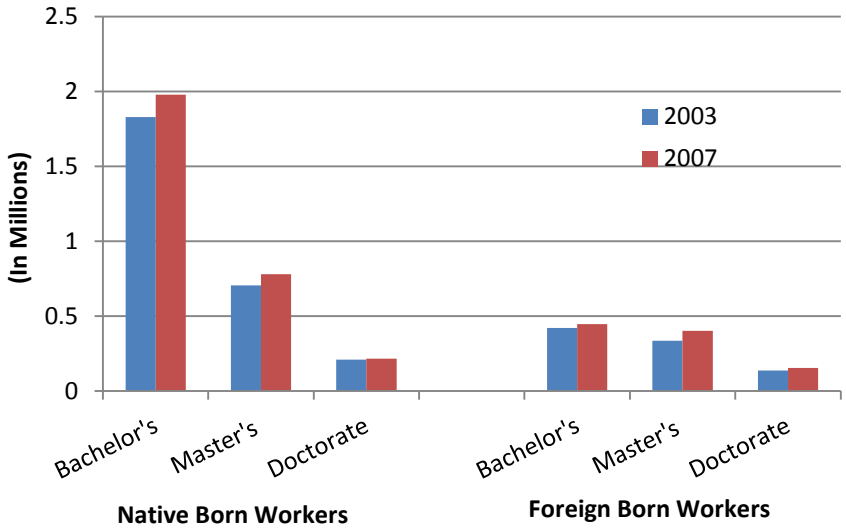


Figure C-10

The estimated overall proportion of the foreign born rose only slightly over these 4 years (from 24.6% to 25.2%) but increased by 2 percentage points each for those with master's degrees and doctorates in this short span.

Details on the proportion of foreign-born S&E degree holders by field of degree are shown in **Table C-3** based on 2003 SESTAT estimates. At the doctoral level, foreign-born individuals constitute about half the total number of workers in both engineering (51%) and mathematics/computer sciences (48%), up from 41% and 33% a decade earlier.

Table C-3: Proportion of Foreign-Born Degree Holders by Field and Degree Type				
		Highest degree		
Field	All degree levels	Bachelor's	Master's	Doctorate
All S&E	18.8	15.2	27.2	34.6
Computer/mathematical sciences	25.8	19.3	40.5	47.5
Computer sciences	29.9	22.3	46.5	57.4
Mathematics	18.5	14.4	25.5	43.1
Biological/agricultural/environmental life sciences	16.6	12.6	21.2	36.2
Agricultural and food sciences	11.6	8.8	15.9	32.7
Biological sciences	19.0	14.6	23.9	37.4
Environmental life sciences	6.6	4.3	13.5	13.3
Physical sciences	22.9	16.9	28.9	36.9
Chemistry	25.3	18.1	42.1	37.0
Geosciences	11.3	8.3	13.0	26.2
Physics/astronomy	32.6	27.4	34.4	40.1
Other physical sciences	16.3	14.1	11.1	48.7
Social sciences	11.5	10.8	13.3	16.9
Economics	21.7	19.8	30.5	31.5
Political science	11.0	9.5	17.1	24.2
Psychology	9.7	10.1	8.5	9.8
Sociology/anthropology	7.2	6.7	10.2	13.6
Other social sciences	13.0	10.6	18.2	31.3
Engineering	26.8	21.5	38.3	50.6
Aerospace/aeronautical/astronautical	16.4	9.7	29.6	52.6
Chemical	26.0	17.7	49.4	47.0
Civil	24.9	19.7	39.3	54.2
Electrical	34.1	28.1	45.9	57.5
Industrial	21.5	17.5	33.1	42.0
Mechanical	23.0	19.6	34.3	52.2
Other engineering	23.4	18.8	25.8	44.6

Only in the geosciences and the social sciences are the foreign born significantly less than a third of doctorate holders in S&E fields. At the bachelor's degree level, 15% of S&E degree holders were foreign born, ranging from 7% of individuals in sociology/anthropology to 27% in physics/astronomy and 28% in electrical engineering. Given the continuing increase in foreign participation, it is likely that these 2003-based percentages are conservative estimates.

Appendix D

U.S. Science and Engineering (S&E) Degree Awards to U.S. Citizens and Temporary Residents[9]

The data in this appendix is derived from the data tables provided by the National Science Foundation (NSF). All analysis in this appendix should be attributed to NSF.

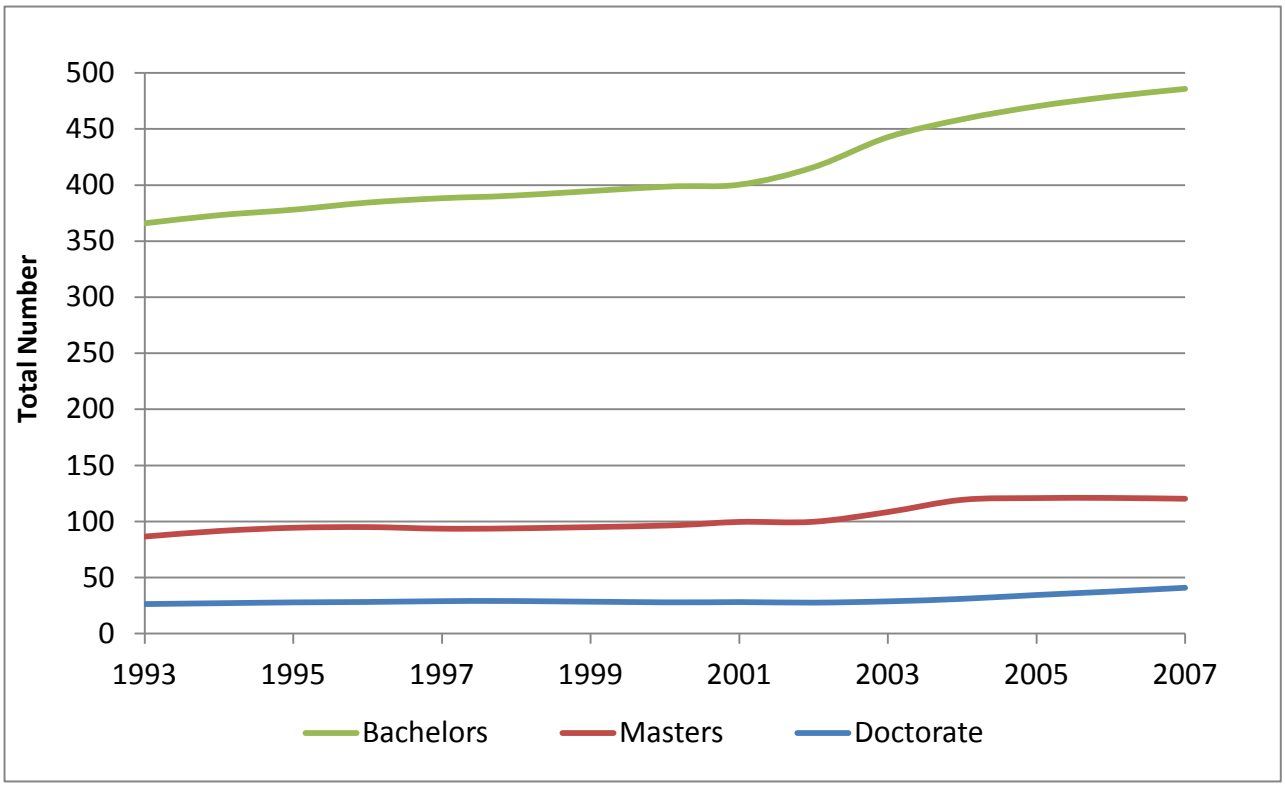


Figure D-1: Degrees in Science and Engineering for U.S. Citizens and Permanent Resident by Degree Type, 1993-2007

[9] This appendix is taken directly from the National Science Foundation's *Science and Engineering Indicators: 2010*. Some of the charts have been formatted to make for easier readability.

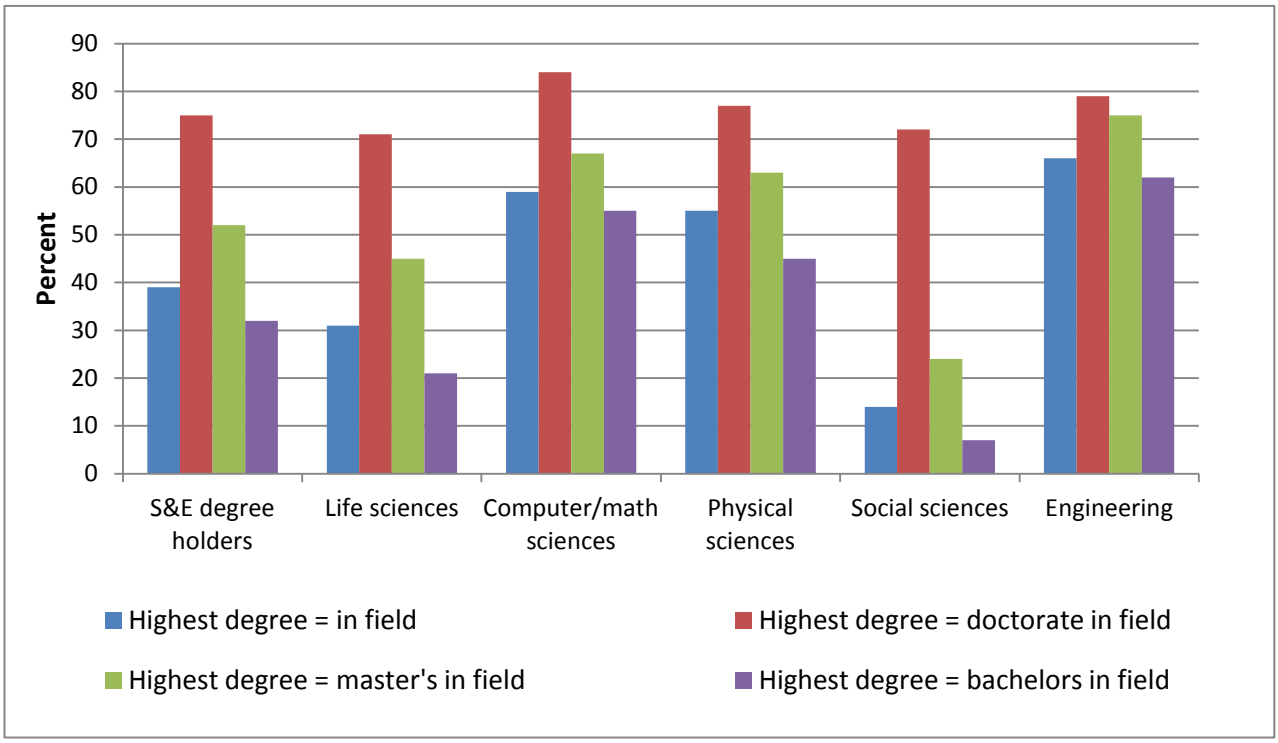


Figure D-2: S&E degree holders working in S&E occupations, by degree field: 2006

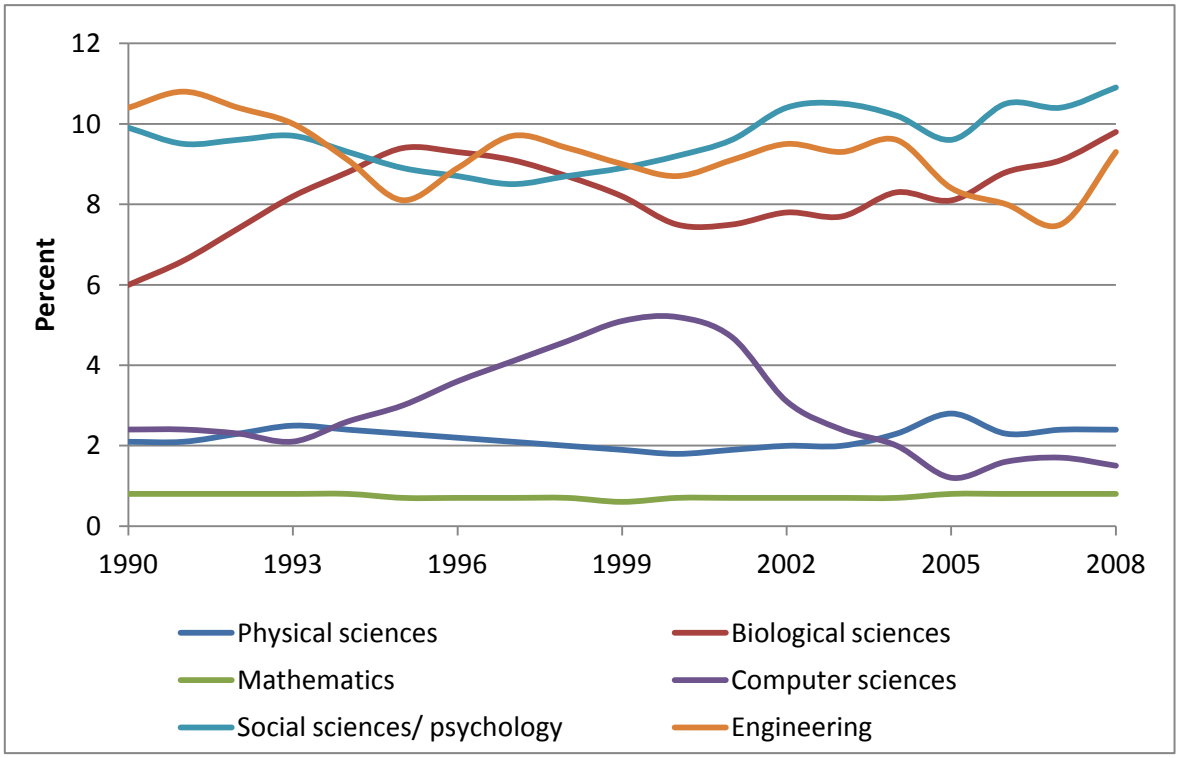


Figure D-3: College freshmen intending S&E major, by field: 1990–2008

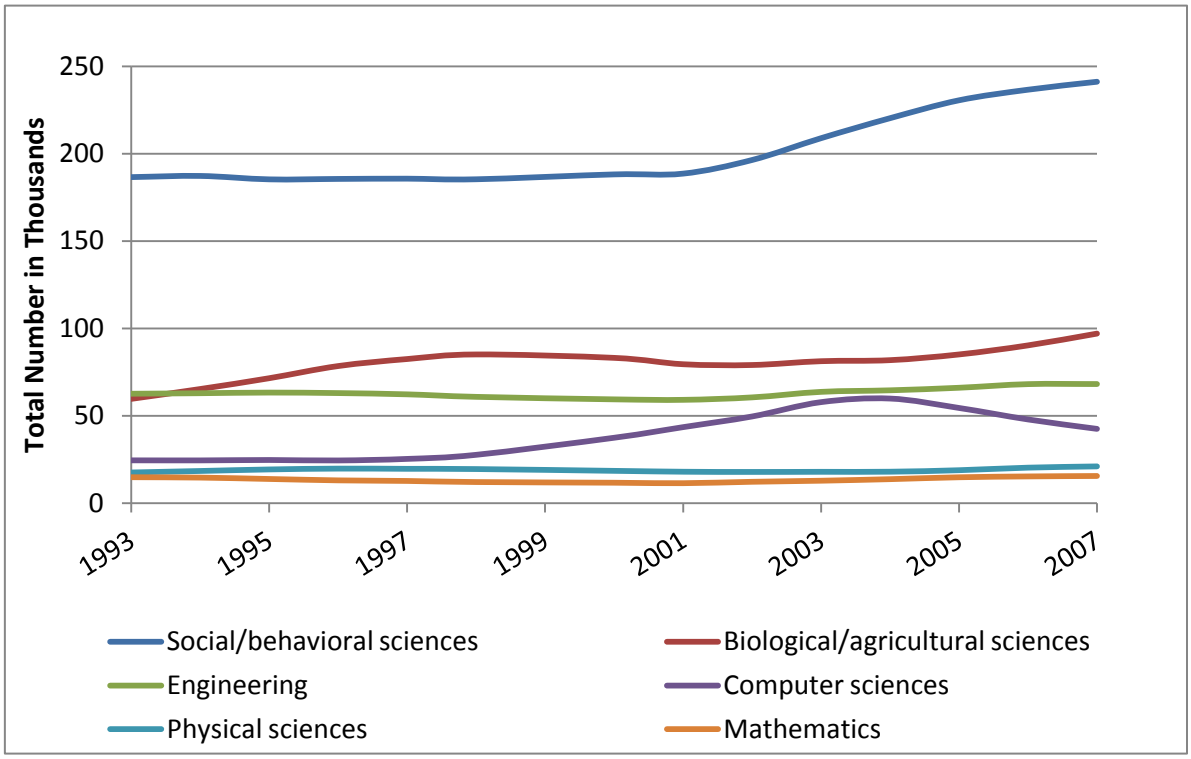


Figure D-4: S&E bachelor's degrees, by field: 1993–2007

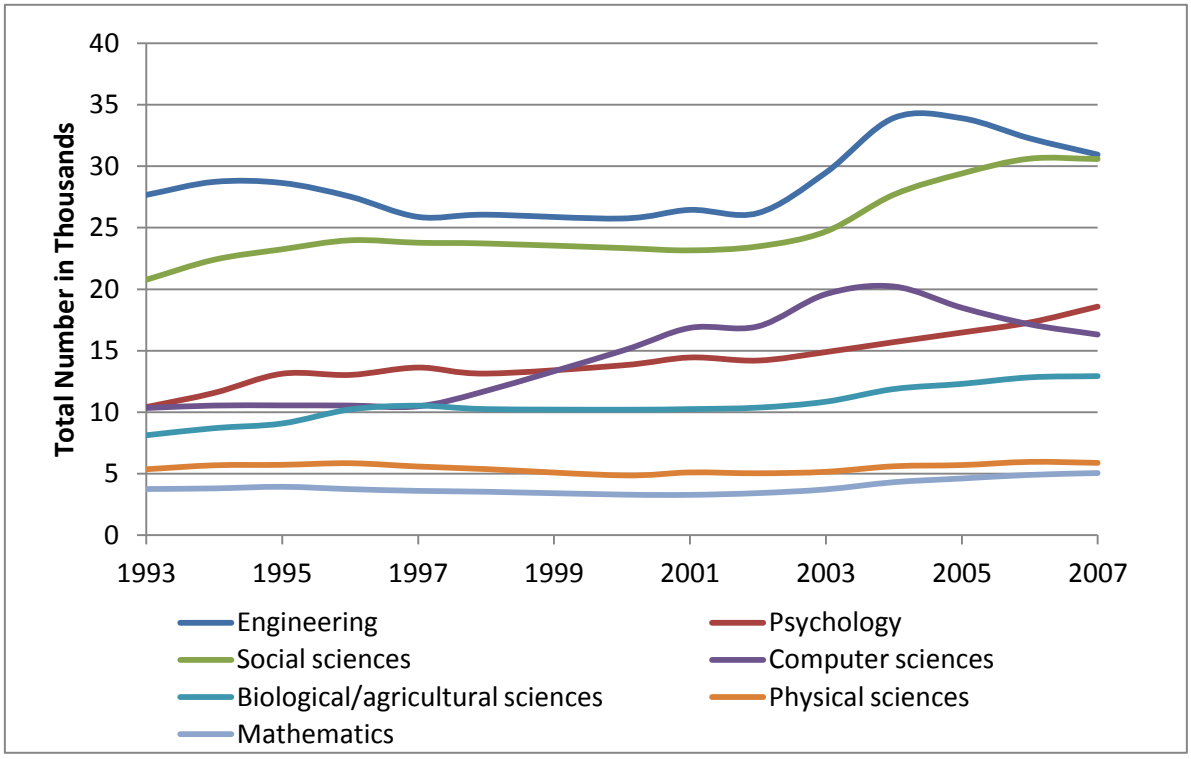


Figure D-5: S&E master's degrees, by field: 1993–2007

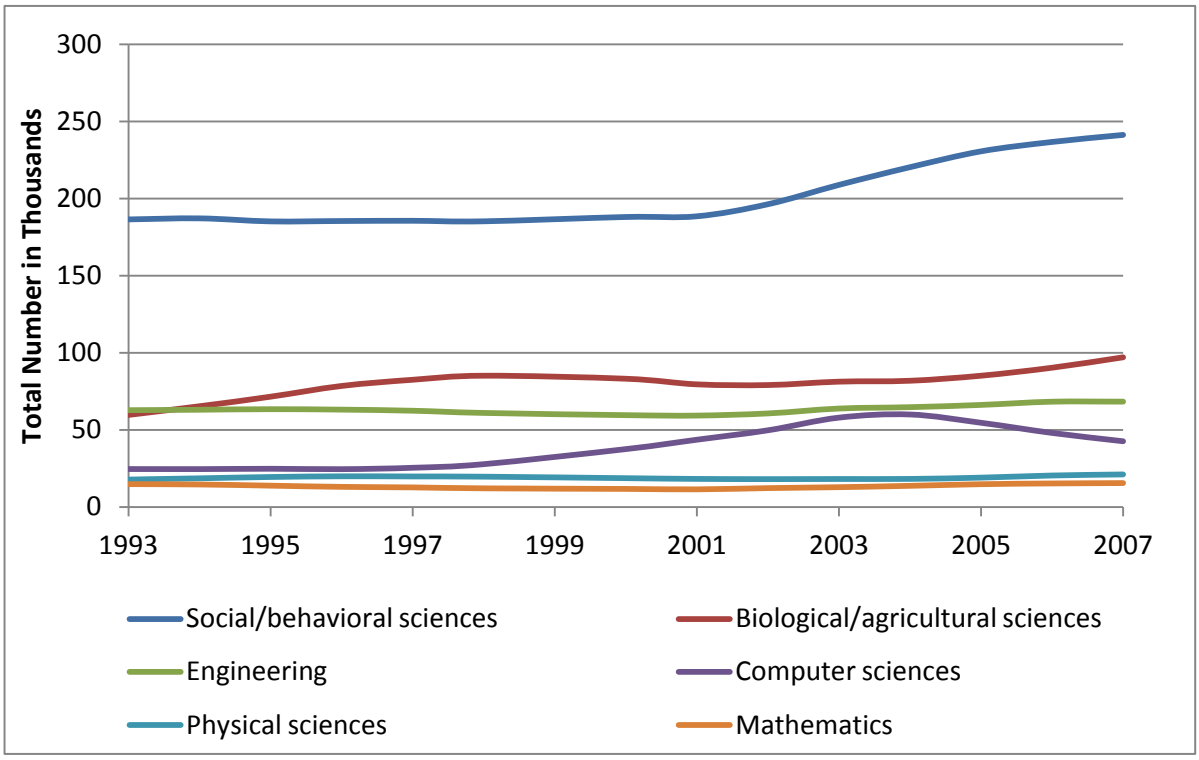


Figure D-6: S&E Doctorate degrees, by field: 1993–2007

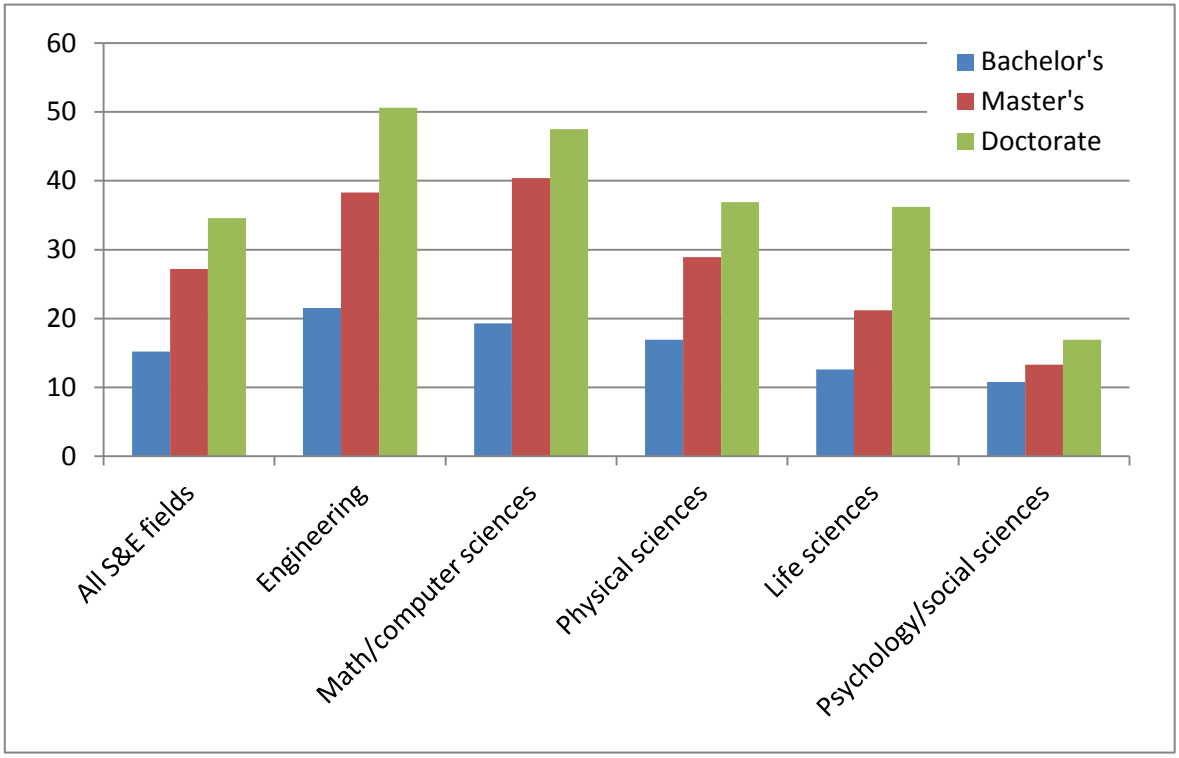


Figure D-7: Foreign-born degree holders with highest degree in S&E, by field and degree level: 2006